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# Regional Implications of the Great Recession

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**Abstract:** This paper investigates the effects of the Great Recession on state output, tracking the size of lost output and the recovery time using quarterly real Gross State Product (GSP) for 2007-2013. This paper defines two different measures of the Okun Gap, one relative to the state GSP level at the beginning of the recession and another relative to the forecast state GSP level. The initial analysis of the data shows substantial variation among the states for both definitions of the Okun Gap. Regressions of the Okun Gap on education, employment in construction and government, the state foreclosure rate, and regional dummy variables were estimated. The foreclosure rate had a significant negative role in each state's gap performance; the industry variables did not test significant. Education attainment showed mixed results. The regional fixed effects variables provide limited understanding, with only the Plains region testing significant.

## 1. Introduction

The Great Recession left its mark on U.S. economy in a variety of ways, including lost output due to the cyclical downturn, higher unemployment rates, and wage stagnation. Apart from the usual measures of the damage to the economy from the Great Recession, a general feeling of malaise persisted past the official end of the recession in 2009. Consumer confidence fell 20 points in five quarters and did not reach its 2007 IV level until 2010 III. This paper investigates the effects of the Great Recession on state output as part of the growing literature assessing the costs of this recent economic downturn. The analysis focuses on measuring Okun's Gap, an alternative to gauging recovery by growth in real per capita incomes.

In August 2014, the Bureau of Economic Analysis announced the availability of quarterly real Gross State Product (GSP) for the period 2005-2013, noting that "these new statistics provide a more complete picture of economic growth across states that can be used with other regional data to gain a better understanding of regional economies as they evolve from quarter to quarter" (BEA, 2014). This paper uses these newly released data to calculate two variants of the Okun Gap. We then investigate the timing and depth of the 2007-2009 recession in each state and the causes of GSP declines over the period.

Empirical estimation of Okun Gap and Okun's Law has been conducted at the national level and, more recently, at the regional level in the U.S. and several other countries. While research generally confirms the presence of Okun's Law for countries, the results are more mixed for regional investigations. Regional studies typically find divergent experiences in recessions and a wider range of responses of GDP to changes in employment.

This paper defines two different measures of the Okun Gap. The first measures each state's actual real GSP relative to the state's 2007 IV level, while the other measures actual GSP relative to an estimate of potential real GSP. After an initial analysis of these two measures, we estimate two regressions to explain differences among the states based on the structure of employment, educational attainment, the housing foreclosure rate, and regional dummy variables.

## 2. Literature review

The Okun Gap was defined in 1962 when Arthur Okun first introduced the idea of using potential GNP as a benchmark for recession policy (Okun, 1962). The severity of a recession is determined as the difference between actual and potential real GDP. The Okun Gap was then used to define Okun's Law to determine the relationship between the departures from the natural rate of unemployment to departures of real output from potential.

Research has focused on Okun's Law at the national level, and the empirical measure of this relationship is well established. For example, Daly et al. (2014) examined the aftermath of the 2007-2009 recession at the national level for the U.S. While it appeared that unemployment rose more quickly in 2008 and 2009 than would have been predicted by the relatively modest declines in GDP, that phenomenon resulted from using preliminary data. Once the GDP revisions were completed, the U.S. experience was typical of past deep recessions followed by slow recoveries such as the 1973 recession.

Two studies looked at the state-level Okun Gap. Connaughton and Madsen (2009) analyzed the regional effects of the 2001 recession by examining each state's cumulative five-year loss of output relative to that state's 2000 level of real GSP. The impact of the recession was diverse. Hawaii's economy outperformed its forecast GSP by 41% of its 2000 GSP. In contrast, Colorado's cumulative five-year losses were nearly 62% of its 2000 GSP. Thirty-six of fifty states experienced lost output in the recession. Regression estimates indicated that both the share of the adult population with a 4-year college degree and the share of employment in manufacturing were significant in explaining a state's Okun Gap. The coefficients of five of the seven regional dummy variables were also significant in explaining the state's Okun Gap.

Connaughton and Madsen (1985) examined the impact of the 1981-1982 recession on state and regional economies. The paper used state-specific estimates of real Gross State Product to assess the regional impacts. The results showed a wide variation in the performances of state economies when measured by annualized rates of change in real GSP. Percent changes in real GSP ranged from a decline of 10.8% in Iowa to an increase of 4.6% in Alaska. Additionally, northern states generally showed larger declines in real GSP than southern states, and there were substantial differences in industry specific impacts by state.

At the regional level, a number of studies have estimated the strength of Okun's Law. Freeman (2000) used 1959-1997 data, finding that "there do not appear to be significant interregional differences in the response of output to changes in unemployment rates..." (p. 568). Similar long-term regional studies on Okun's Law have been conducted on Greek regions (Apergis and Rezitis, 2003; Christopoulos 2004), Canada (Adanu, 2005), and Spain (Villaverde and Maza, 2007). An examination of the 22 French regions by Binet and Facchini (2013) finds that fourteen administrative regions demonstrate the validity of Okun's Law with some variation in the strength of the response. Oberst and Oelgemöller (2013) examined German regions and determined that while Okun's Law holds, the size of the estimated effect is lower than expected.

Pereira (2014) looked at Virginia MSAs and the DC area during the Great Recession to estimate Okun's Law. He finds that accounting for the spillover effects yields a strong relationship between output and unemployment. Local relationships are much weaker when the spillover effects are ignored.

This paper examines the Okun Gap following the 2007-2009 U.S. recession using state-level quarterly real GSP data. We calculate two different Okun Gaps. The static gap estimates cumulative GSP losses after 2007 IV as a share of observed real GSP for 2007 IV. The dynamic gap uses the long-term trend of state GSP to calculate a quarterly growth rate for each state. The dynamic gap is the cumulative GSP losses relative to the forecast as a share of observed GSP for 2007 IV. These data indicate a wide range of state experiences. They are described in detail in the next section.

This study also considers what factors explain the size of the gaps at the state level. There are several types of explanatory variables that are consistently identified as having an influence on state economic performance. The selection of explanatory variables for this study is based on earlier studies which focused on changes in state performance measured by per capita personal income over time. Berry and Kaserman (1993) found low taxes and strong support for higher education to be major factors in explaining variation in state economic growth over the extended time period of 1929-1987. Berry and Kaserman also included as an explanatory variable the percentage of employment in manufacturing. Levernier et al. (1995) utilized economic, demographic, human capital, and labor market variables along with regional dummies to capture unmeasured regional fixed

effects. Vohra (1997) specifies differences in demographics, industrial mix, human capital, and technology or physical capital to explain forces influencing productivity and the rate of convergence among states. Vohra's findings for 1969-1988 suggest that human capital and the composition of the labor force are the most important explanatory variables. Further, that study identified a changing role of manufacturing and service employment in explaining state performance over time.

Walden (2014) analyzed the rate of recovery from the Great Recession using the growth rate of real GSP as the dependent variable. The state's industry mix affected the recovery rate after the Great Recession. Also, a one percentage point increase in the state's population between 2009 and 2012 resulted in nearly a one-percentage point increase in real GSP growth. The GSP growth rates Walden analyzed are an alternative measure of recovery to the Okun Gap analyzed here.

## 3. Data and initial analysis

This study uses quarterly real GSP for 2007 IV to 2013 IV provided by the Bureau of Economic Analysis. Using these data, we measure two different gaps in real GSP. The static gap is the difference between observed quarterly real GSP and real GSP for 2007 IV. This measure indicates, in so far as possible, the lost production attributable to declines in GSP below the 2007 IV level. It is a snapshot of the state's journey through the recession and back to its 2007 IV level.

The dynamic gap is the difference between observed quarterly real GSP and calculated potential real quarterly GSP. Annual GSP data for 1997 through 2007 were used to calculate a quarterly GSP growth rate. This rate was applied to the 2007 IV actual state GSP to forecast potential real GSP through 2013 IV. The dynamic gap is the difference between actual real GSP and the forecast potential GSP. This approach attempts to capture the full cost of the 2007-2009 recession by including both output lost relative to 2007 and output lost relative to the economy's likely path had the recession not occurred.

For both the static and dynamic gap calculations, the gap is the sum of quarterly losses from the onset of the first negative gap through to the end of that series of negative gaps. In some cases, states have a small positive gap in the middle of a series of negatives. Provided the positive gap is smaller than the next negative gap, the positive quarter is included in the loss calculations. Many states had a negative gap in 2008 I followed by a small positive gap in 2008 II and then negative gaps for several quarters. The calculated gaps are presented in the Appendix.

### 3.1. Static gap analysis

An overview of the static gap calculations is shown in Table 1. Three states (North Dakota, South Dakota, and West Virginia) had no decline in quarterly GSP compared to 2007 IV, and another three states (Louisiana, Oregon, and Wyoming) had losses for only one quarter. The four states that started the recession in 2009 had short recessions; their average duration was three quarters, compared to an overall average of 11.62 quarters.

**Table 1.** Summary statistics of static gaps.

| Start Date | # | End date | # | Duration | # | % Loss | # |
|---|---|---|---|---|---|---|---|
| None | 3 | None | 3 | 0 quarters | 3 | >50% | 2 |
| 2008 I | 21 | 2008 | 2 | 1-5 | 10 | 20 to 49% | 3 |
| 2008 II | 5 | 2009 | 9 | 6-10 | 10 | 10 to 19% | 11 |
| 2008 III | 11 | 2010 | 10 | 11-15 | 14 | 1 to 9% | 30 |
| 2008 IV | 6 | 2011 | 14 | 16-20 | 4 | None | 3 |
| 2009 I | 0 | 2012 | 1 | 21-24+ | 9 | | |
| 2009 II | 3 | 2013 | 4 | | | | |
| 2009 III | 0 | After 2013 | 7 | | | | |
| 2009 IV | 1 | | | | | | |
| Median | 2008 II | Median | 2011 I | Mean | 11.62 | Mean | 10.44% |

GSP losses exceeded 50% of 2007 IV GSP for Nevada (68.11%) and Florida (50.80%). Three more states had losses between 20% and 50% of 2007 IV GSP: Arizona (40.21%), Connecticut (36.06%), and Michigan (30.32%). At the other end of the spectrum, eight states had GSP losses of less than 1% of 2007 IV GSP: Nebraska (0.93%), Maryland (0.90%), Virginia (0.84%), New Mexico (0.78%), Oklahoma (0.68%), Louisiana (0.24%), Wyoming (0.03%), and Oregon (0.02%).

At the national level, the static gap for the US was $971 billion, 6.47% of 2007 IV GDP. The negative gap began in 2008 I and ended fourteen quarters later, 2011 II. Sorting the states into their BEA regions and by the percentage loss reveals a pattern of unequal incidence of losses. These data are shown in Table 2. While no region escaped the recession, the losses in the Plains Region were relatively small, ranging from 8.06% in Iowa to 0% for North and South Dakota. In the other seven regions, the state with the greatest loss had a considerably larger loss than the other states.

**Table 2.** Percentage static losses by region.

| State | Loss/ Starting GSP | State | Loss/ Starting GSP |
|---|---|---|---|
| New England Region (1) | | Southeast Region (5) | |
| Connecticut | 36.06% | Florida | 50.80% |
| Maine | 9.82% | Georgia | 18.55% |
| Massachusetts | 5.20% | South Carolina | 13.56% |
| New Hampshire | 5.01% | Arkansas | 13.52% |
| Vermont | 2.85% | Mississippi | 13.47% |
| Rhode Island | 2.31% | Tennessee | 10.55% |
| Mideast Region (2) | | Alabama | 7.59% |
| New Jersey | 17.84% | Kentucky | 6.43% |
| Pennsylvania | 4.33% | North Carolina | 3.60% |
| Delaware | 3.75% | Virginia | 0.84% |
| New York | 1.33% | Louisiana | 0.24% |
| Maryland | 0.90% | West Virginia | 0.00% |
| Great Lakes Region (3) | | Southwest Region (6) | |
| Michigan | 30.32% | Arizona | 40.21% |
| Illinois | 16.11% | Texas | 1.26% |
| Indiana | 14.71% | New Mexico | 0.78% |
| Ohio | 13.02% | Oklahoma | 0.68% |
| Wisconsin | 6.59% | Rocky Mountain Region (7) | |
| Plains Region (4) | | Idaho | 22.68% |
| Iowa | 8.06% | Utah | 9.56% |
| Minnesota | 5.28% | Montana | 7.37% |
| Kansas | 5.08% | Colorado | 5.98% |
| Missouri | 1.43% | Wyoming | 0.04% |
| Nebraska | 0.93% | Far West Region (8) | |
| North Dakota | 0.00% | Nevada | 68.11% |
| South Dakota | 0.00% | California | 16.47% |
| | | Washington | 10.53% |
| | | Hawaii | 6.97% |
| | | Alaska | 1.14% |
| | | Oregon | 0.02% |

To demonstrate the level of inequality in the impact of the recession, Table 3 shows two different ratios for each region. The second column is the ratio of the highest percentage loss in the region to the second-highest value. For example, in New England, Connecticut's percentage loss was 36.06% while

Maine's percentage loss was 9.82%, for a ratio of 3.67. This ratio shows that the incidence of losses was relatively evenly spread (ratios of 1.53 to 4.13) in all other regions except the Southwest. Arizona's loss of 40.21% dominates the Southwest region, where the other three states experienced losses of less than 2% of 2007 IV GSP.

**Table 3.** Relative percentage loss: static gaps.

| Region | Ratio of #1 to #2 | Ratio of #1 to Smallest Non-zero Loss |
|---|---|---|
| New England | 3.67 | 15.58 |
| Mideast | 4.12 | 19.88 |
| Great Lakes | 1.88 | 4.60 |
| Plains | 1.53 | 8.68 |
| Southeast | 2.74 | 214.85 |
| Southwest | 32.01 | 58.79 |
| Rocky Mountain | 2.37 | 623.53 |
| Far West | 4.13 | 4,545.21 |

The last column in Table 3 measures the ratio of the greatest percentage loss to the smallest non-zero loss in the region, a way of indicating the top-to-bottom inequality of percentage losses in the region. The Plains and Great Lakes Regions show relatively homogeneous losses while this measure amplifies the inequality in New England, Mideast, and the Southwest Regions. The large ratios for the Southeast, Rocky Mountains, and the Far West are driven mainly by values less than 1% for the states with the smallest losses.

### 3.2. Dynamic gap analysis

The dynamic gap calculations underline the severity of the 2007-2009 recession. These are shown in Table 4. The average duration of the gap is 21.80 quarters, an understatement since 46 states had not yet reached their estimated potential GSP at the end of the period. North Dakota is the only state to have a positive dynamic gap for the period. The three states with relatively short periods of losses were Louisiana (1 quarter), Alaska (3 quarters), and West Virginia (4 quarters).

While the average loss is just over six months of GSP, four states had gaps that were more than a full year's GSP. Nevada leads the list with a percentage loss of 170.23%. The other states were Arizona (147.18%), Florida (128.27%), and Idaho (115.99%). Four states lost between 80 and 100% of GSP: California (94.39%), Connecticut (92.72%), Utah (89.80%), and Georgia (81.25%). Only North Dakota's economy performed above potential throughout the period. The four states with relatively small losses were Louisiana (0.31%), West Virginia (1.22%), Alaska (1.58%), and Nebraska (11.97%). At the national level, the dynamic gap for the US was $8,338 billion, 55.62% of 2007 IV GDP. The negative gap began in 2008 I and had not yet ended by 2013 IV.

**Table 4.** Summary statistics of dynamic gaps.

| Start Date | # | End date | # | Duration | # | % Loss | # |
|---|---|---|---|---|---|---|---|
| None | 1 | None | 1 | 0 quarters | 1 | >100% | 4 |
| 2008 I | 39 | 2008 | 2 | 1-5 | 3 | 75 to 99% | 4 |
| 2008 II | 3 | 2009 | 0 | 6-10 | 0 | 50 to 74% | 15 |
| 2008 III | 3 | 2010 | 1 | 11-15 | 0 | 25 to 49% | 22 |
| 2008 IV | 1 | 2011 | 0 | 16-20 | 2 | 0 to 25% | 4 |
| 2009 I | 1 | 2012 | 0 | 21-24+ | 44 | None | 1 |
| 2009 II | 2 | 2013 IV | 46 | | | | |
| 2009 III | 0 | | | | | | |
| 2009 IV | 0 | | | | | | |
| Median | 2008 I | Median | 2013 IV | Mean | 21.80 | Mean | 52.98% |

Table 5 contains the dynamic gaps for each state sorted by region. Again, the dynamic gap measurement shows that no region escaped the recession. As noted above, a small number of states have relatively small dynamic gaps. The impact of the recession on most regions appears more evenly distributed than with static gaps.

The measures of inequality used for the static gaps are repeated for the dynamic gaps in Table 6. The gap between the highest percentage loss and the next highest is compressed into a range of 1.07 to 4.05. The ratio of greatest to smallest non-zero losses is similarly compressed in six of the eight regions, ranging from 2.03 to 4.81. The ratios for the Southwest and Far West regions are dominated by the small losses for Louisiana and Alaska, respectively. If the ratio excludes these states from the calculation, the top-to-bottom ratios are 5.05 and 4.91, respectively. With the exception of a few high-performing states, the dynamic gaps indicate a relatively uniform experience of losses.

**Table 5.** Percentage dynamic losses by region.

| State | Loss/ Starting GSP | State | Loss/ Starting GSP |
|---|---|---|---|
| New England Region (1) | | Southeast Region (5) | |
| Connecticut | 92.72% | Florida | 128.27% |
| New Hampshire | 55.75% | Georgia | 81.25% |
| Maine | 51.70% | Arkansas | 69.99% |
| Massachusetts | 48.79% | North Carolina | 59.34% |
| Rhode Island | 42.41% | South Carolina | 57.36% |
| Vermont | 36.21% | Alabama | 53.19% |
| Mideast Region (2) | | Virginia | 52.96% |
| New Jersey | 59.05% | Tennessee | 49.58% |
| Maryland | 47.87% | Mississippi | 47.76% |
| Delaware | 45.40% | Kentucky | 25.42% |
| Pennsylvania | 38.13% | West Virginia | 1.22% |
| New York | 29.02% | Louisiana | 0.31% |
| Great Lakes Region (3) | | Southwest Region (6) | |
| Indiana | 57.60% | Arizona | 147.18% |
| Illinois | 53.82% | New Mexico | 36.32% |
| Wisconsin | 44.34% | Texas | 33.65% |
| Michigan | 41.58% | Oklahoma | 33.38% |
| Ohio | 34.47% | Rocky Mountain Region (7) | |
| Plains Region (4) | | Idaho | 115.99% |
| Iowa | 52.14% | Utah | 89.80% |
| Minnesota | 45.95% | Colorado | 63.42% |
| Kansas | 33.71% | Wyoming | 59.81% |
| South Dakota | 27.91% | Montana | 55.59% |
| Missouri | 27.79% | Far West Region (8) | |
| Nebraska | 11.97% | Nevada | 170.23% |
| North Dakota | 0.00% | California | 94.39% |
| | | Washington | 63.94% |
| | | Hawaii | 44.05% |
| | | Oregon | 34.66% |
| | | Alaska | 1.58% |

**Table 6.** Relative percentage loss: dynamic gaps.

| Region | Ratio of #1 to #2 | Ratio of #1 to Smallest Non-zero Loss |
|---|---|---|
| New England | 1.66 | 2.56 |
| Mideast | 1.23 | 2.03 |
| Great Lakes | 1.07 | 4.81 |
| Plains | 1.13 | 4.36 |
| Southeast | 1.58 | 409.63 |
| Southwest | 4.05 | 4.41 |
| Rocky Mountain | 1.29 | 2.09 |
| Far West | 1.80 | 107.43 |

The next several figures illustrate the actual real GSP, predicted GSP, and the two different gaps. Nevada had the largest static and dynamic losses as a share of 2007 IV state GSP. It had not reached its 2007 IV level of real GSP by the end of the study period, as shown in Figure 1. In contrast, North Dakota experience neither a static nor a dynamic gap, as shown in Figure 2. Washington state's results are shown in Figure 3. Many states, including Washington, recovered their 2007 IV level of real GSP during the study period but failed to close the dynamic gap by 2013 IV.

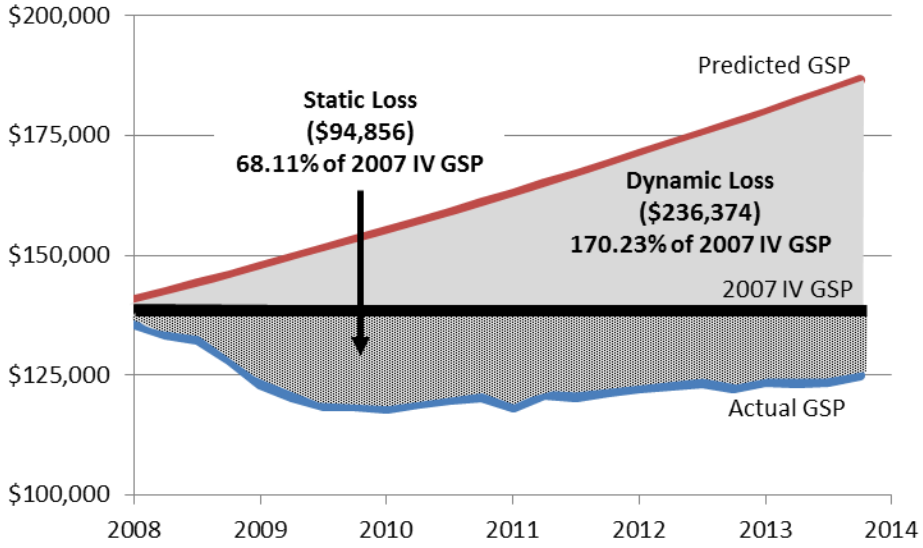


**Figure 1.** Nevada GSP and gaps.

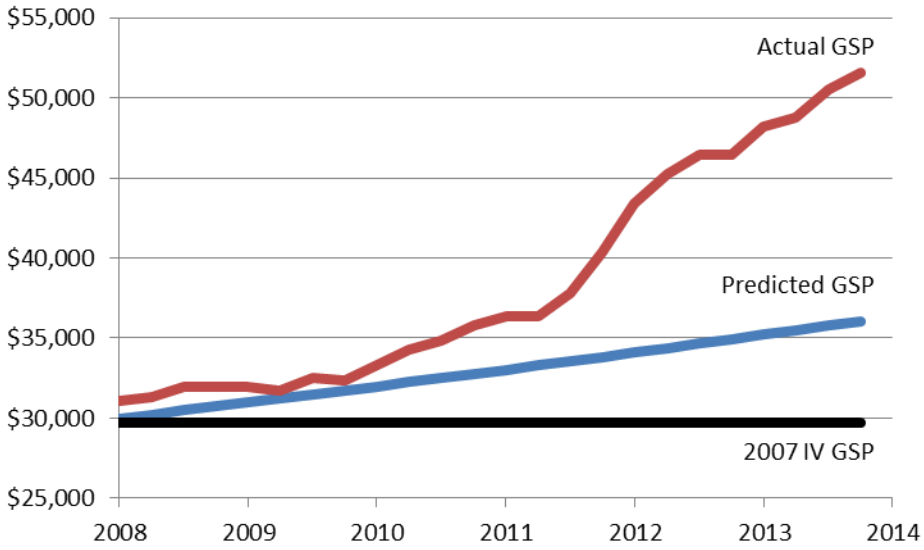


**Figure 2.** North Dakota GSP.

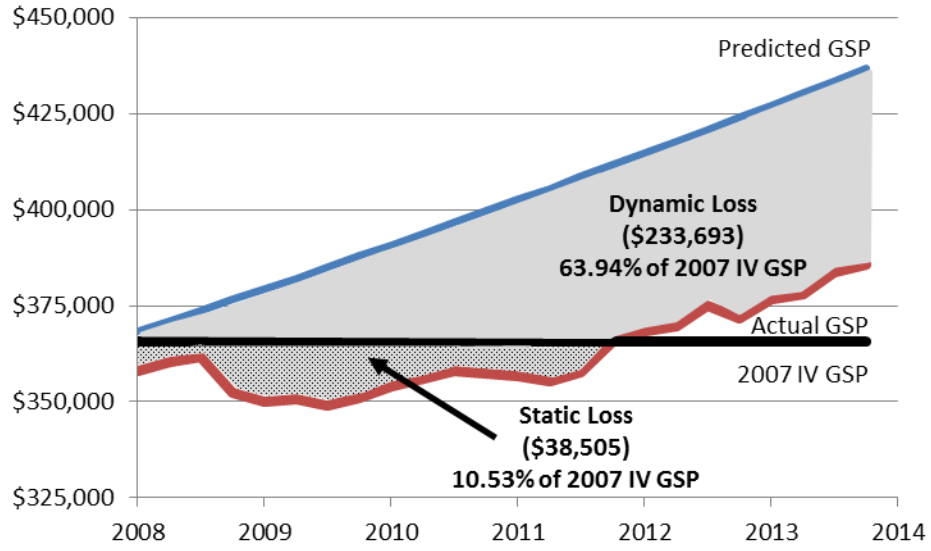


**Figure 3.** Washington GSP and gaps.

Figures 4A through Figure 4D show each state's percentage loss for both static and dynamic gaps. As noted above, several regions have one state with a large gap relative to the other states in the region. For all regions except the Great Lakes and Plains regions, the largest percentage loss as measured by the static gap is more than twice the percentage loss of the second-ranked state. This phenomenon is less pronounced for dynamic gaps. Only the Southwest has a ratio of more than 2:1 for its two largest dynamic gaps.

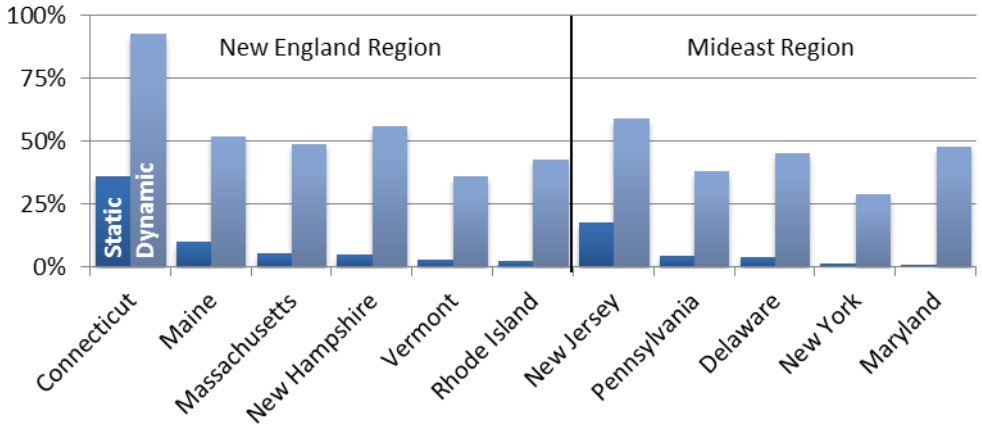


**Figure 4A.** Percentage losses by state in New England and Mideast regions.

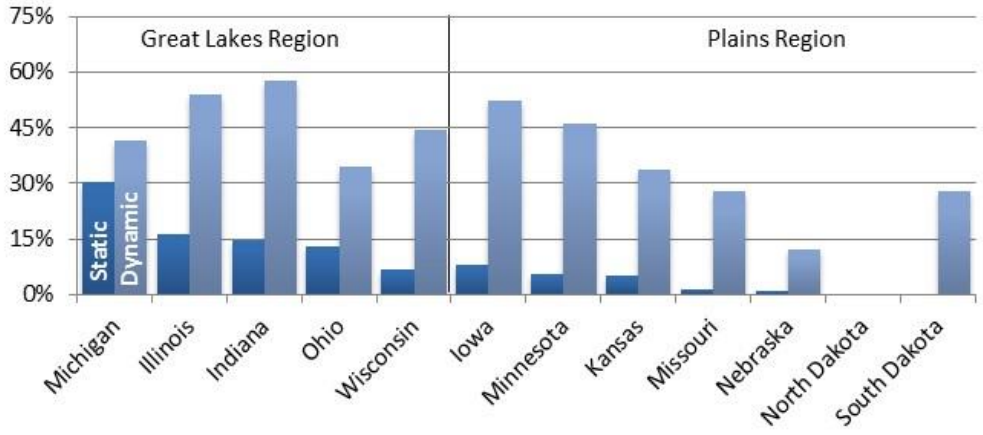


**Figure 4B.** Percentage losses by state in Great Lakes and Plains regions.

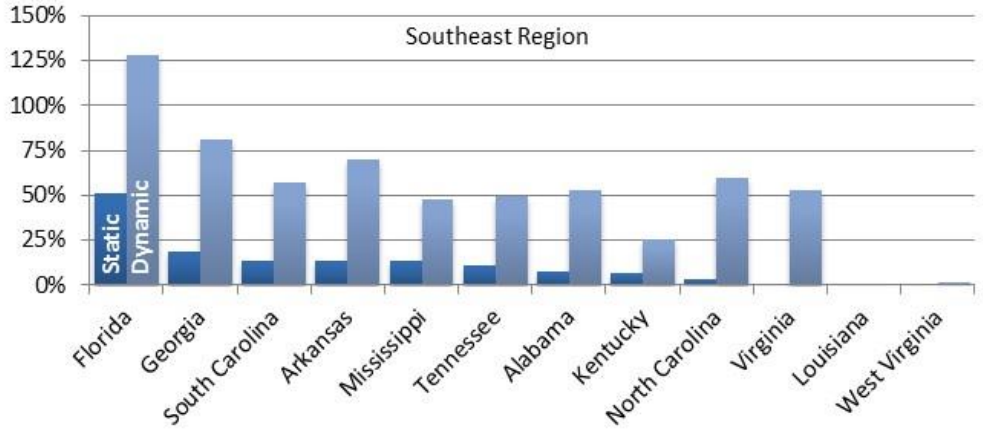


**Figure 4C.** Percentage losses by state in Southeast region.

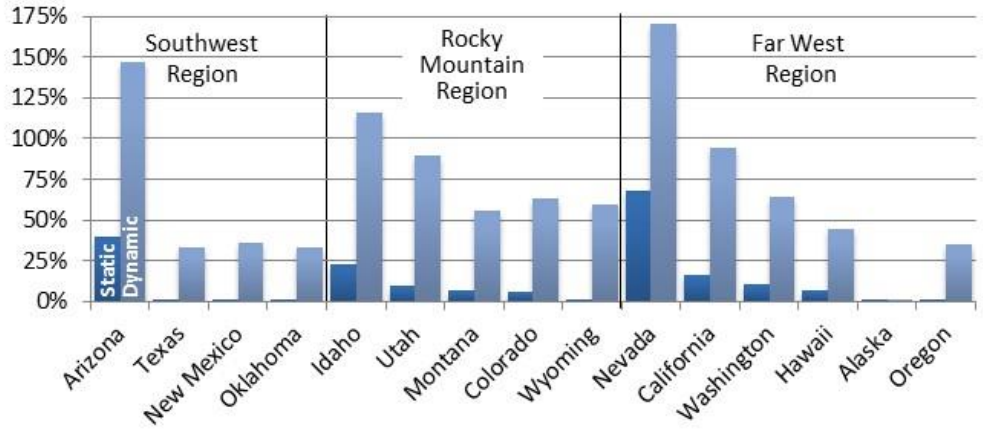


**Figure 4D.** Percentage losses by state in Southwest, Rocky Mountain, and Far West regions.

## 4. Regression results

Two regression models were estimated to explain the variation across states in both the static gap calculation and the dynamic gap calculation. The following specification was used to estimate both the static and dynamic gap variation:

$$\begin{aligned} QWEDGE_i \text{ or } OKWEDGE_i = {} & B_0 + B_1NHS_i \\ & + B_2COL4_i + B_3PCON_i + B_4PGOV_i \\ & + B_5FORECLS_i + B_6ME_i + B_7SE_i + B_8GL_i \\ & + B_9PL_i + B_{10}SW_i + B_{11}RM_i + B_{12}FW_i + E_i . \end{aligned} \quad (1)$$

The variables are defined as follows:

| | |
|---|---|
| $QWEDGE_i$ | The static gap for state i is (the sum of the quarterly difference between actual real GSP and the 2007 IV GSP, summmed over the period when state i's static gap is negative) dvided by state i's 2007 IV real GSP. The variable is expressed as a percentage of the 2007 IV state GSP level. |
| $QOKWEDGE_i$ | The dynamic gap for state i is (the sum of the quarterly differences between forecast GSP and 2007 IV GSP, summed over the period when state i's dynamic gap is negative) divided by state i's 2007 IV real GSP. The variable is expressed as a percentage of the 2007 IV state GSP level. |
| $NHS_i$ | The percentage of workers in state i with less than completed high school education (2007). |
| $COL4_i$ | The percentage of workers in state i with at least a baccalaureate degree (2007). |
| $PCON_i$ | The percentage of workers in state i employed in the construction sector at the start of the recession (2007). |
| $PGOV_i$ | The percentage of workers in state i employed in the government sector at the start of the recession (2007). |
| $FORECLS_i$ | Foreclosure rate in state i in 2009 as a percent of total housing units. |
| $ME_i$ | A regional dummy with a value of 1 if the state is in the Mideast BEA Region and 0 otherwise. |
| $SE_i$ | A regional dummy with a value of 1 if the state is in the Southeast BEA Region and 0 otherwise. |
| $GL_i$ | A regional dummy with a value of 1 if the state is in the Great Lakes BEA Region and 0 otherwise. |
| $PL_i$ | A regional dummy with a value of 1 if the state is in the Plains BEA Region and 0 otherwise. |
| $SW_i$ | A regional dummy with a value of 1 if the state is in the Southwest BEA Region and 0 otherwise. |
| $RM_i$ | A regional dummy with a value of 1 if the state is in the Rocky Mountain BEA Region and 0 otherwise. |
| $FW_i$ | A regional dummy with a value of 1 if the state is in the Far West BEA Region and 0 otherwise. |

The models were estimated for the 50 states using an OLS regression model and White heteroskedasticity-consistent standard errors and covariance. The regression results are reported in Tables 7 and 8. The static gap equation (QWEDGE, Table 7) has an R-squared value of 0.8260 and an F-statistic that tests significant at the 0.01 level. The coefficient on the percent of the population with a four-year degree (COL4) tests significant at the 0.05 level and has the appropriate sign, indicating that a one percent increase in the percent of the population with a four year degree would reduce a state's static gap by 0.6 percent. The coefficient on the percent of the population that does not have a high school degree (NHS) has the expected sign, indicating that a one percent increase in the percent of the population without a high school degree would increase a state's static gap by 0.7 percent. However, the variable does not test significant at the 0.10 level. Neither of the structural employment variables tests significant. The coefficient on the foreclosure rate variable is significant at the 0.01 level and indicates a rather large impact on a state's static gap. A 1 percent increase in a state's percentage of foreclosed homes would produce an 8 percent increase in a state's static gap. The regional fixed effects coefficient for the Far West region is significant at the 0.05 level and indicated that states within that region have a 15 percent lower static gap than states in the omitted region, New England. The regional fixed effects coefficient for the Plains region is significant at the 0.10 level and indicated that states within that region have a 9 percent lower static gap than states in New England. All the other regional fixed coefficient variables are not significant. This is likely because at least one state in that region performed very badly while at least one demonstrated a minimal negative effect. So each of these regions performed like the U.S. as a whole.

**Table 7.** Static gap regression (dependent variable QWEDGE).

| Variable | Coefficient | Std. Error* | t-Statistic | Prob. |
|---|---|---|---|---|
| C | -43.5841 | 37.5863 | -1.1596 | 0.2537 |
| NHS | 0.7354 | 0.4503 | 1.6332 | 0.1109 |
| COL4 | -0.6325 | 0.2549 | -2.4815 | 0.0177 |
| PCON | -1.5835 | 1.1568 | -1.3689 | 0.1793 |
| PGOV | 0.6046 | 0.5338 | 1.1326 | 0.2647 |
| FORECLS | 8.1516 | 0.8277 | 9.8486 | 0.0000 |
| ME | -5.6619 | 5.2303 | -1.0825 | 0.2860 |
| SE | -4.1099 | 5.8610 | -0.7012 | 0.4876 |
| GL | -6.5855 | 5.5759 | -1.1811 | 0.2451 |
| PL | -9.3506 | 4.7680 | -1.9611 | 0.0574 |
| SW | -10.1584 | 6.3965 | -1.5881 | 0.1208 |
| RM | -9.0168 | 5.6674 | -1.5910 | 0.1201 |
| FW | -15.2380 | 6.9760 | -2.1843 | 0.0354 |
| R-squared | 0.8260 | | Mean dependent var | 10.4382 |
| Adjusted R-squared | 0.7695 | | S.D. dependent var | 13.6887 |
| S.E. of regression | 6.5714 | | F-statistic | 14.6351 |
| Durbin-Watson stat | 2.3209 | | N | 50 |

** White Heteroskedasticity-Consistent Standard Errors & Covariance.*

The dynamic gap equation (OKWEDGE, Table 8) has an R-squared value of 0.7971 and an F-statistic that tests significant at the 0.01 level. None of the education or structural variables test significant at the 0.10 level. However, they have the expected sign regarding their impact on a state's dynamic gap. The coefficient on the foreclosure rate variable is significant at the 0.01 level and indicates a rather large impact on a state's dynamic gap. A 1 percent increase in a state's percentage of foreclosed homes would produce a 14 percent increase in a state's dynamic gap. The regional fixed effects coefficient for the Great Lakes region is significant at the 0.05 level and indicated that states within that region have a 21 percent lower dynamic gap than states in New England. The regional fixed effects coefficient for the Plains region is significant at the 0.10 level and indicated that states within that region have an 18 percent lower dynamic gap than states in New England. All the other regional fixed coefficient variables are not significant. This is likely because at least one state in that region performed very badly while at least one demonstrated a minimal negative effect. So each of these regions performed like the U.S. as a whole.

## 5. Conclusion

The severity of the Great Recession has stimulated a range of research on the size of the downturn and various aspects of the recovery. This paper analyzes Okun's Gap at the state level. This approach is complementary to other studies that consider real per capital income as the measure of the Great Recession and subsequent recovery.

This paper defines two different measures of the Okun Gap. The static gap measures the cumulative loss in GSP compared to the benchmark GSP in 2007 IV. This measure indicates lost output in the time the state takes to recover to its starting level of GSP. The dynamic gap uses a long-term trend for each state's GSP to forecast quarterly real potential output for the study period, 2007 IV to 2013 IV. The dynamic gap is calculated as the sum of the quarterly losses in actual real state GSP relative to the forecast real GSP for the period when the gap was negative. To enable cross-state comparisons, each gap is divided by the state's 2007 IV real GSP. The resulting number is the calculated loss as a percentage of 2007 IV real GSP.

**Table 8.** Dynamic gap regression (dependent variable OKWEDGE).

| Variable | Coefficient | Std. Error* | t-Statistic | Prob. |
|---|---|---|---|---|
| C | -88.6118 | 100.7360 | -0.8796 | 0.3847 |
| NHS | 1.7576 | 1.2373 | 1.4205 | 0.1638 |
| COL4 | -0.0264 | 0.7755 | -0.0340 | 0.9731 |
| PCON | 0.6619 | 3.2268 | 0.2051 | 0.8386 |
| PGOV | -1.8068 | 1.5614 | -1.1572 | 0.2546 |
| FORECLS | 14.0239 | 2.6842 | 5.2245 | 0.0000 |
| ME | -10.5113 | 8.2636 | -1.2720 | 0.2113 |
| SE | 5.2763 | 11.8544 | 0.4451 | 0.6588 |
| GL | -21.7444 | 10.7615 | -2.0206 | 0.0506 |
| PL | -18.6623 | 9.5841 | -1.9472 | 0.0591 |
| SW | 6.4459 | 16.4189 | 0.3926 | 0.6969 |
| RM | 8.1940 | 15.0009 | 0.5462 | 0.5882 |
| FW | -16.1511 | 14.3811 | -1.1231 | 0.2686 |
| R-squared | 0.7971 | | Mean dependent var | 52.9802 |
| Adjusted R-squared | 0.7313 | | S.D. dependent var | 34.0359 |
| S.E. of regression | 17.6442 | | F-statistic | 12.1112 |
| Durbin-Watson stat | 1.9558 | | N | 50 |

** White Heteroskedasticity-Consistent Standard Errors & Covariance.*

The initial analysis of the data show substantial variation among the states. A few states escaped the Great Recession. Our static gap analysis indicated three states had no losses from the Great Recession and another three other states had only one quarter of output below the 2007 IV benchmark level. The average static loss was 10% of state GSP (just over 5 weeks of lost output) and the average duration of lost output was nearly 3 years.

Several states suffered major losses as measured by the static gap. Nevada lost nearly 3 quarters of output and Florida lost 2 quarters of output. Nine states had losses that lasted for at least 21 quarters, with several still below their 2007 IV output level at the end of the study period.

Losses were even greater for the dynamic gaps. Nevada had the highest percentage loss at 170% of 2007 IV GSP. Arizona, Florida, and Idaho also lost more than a year's output when actual output is compared to potential. Four states with relatively small losses were Louisiana, West Virginia, Alaska, and Nebraska. Only North Dakota had a zero dynamic gap. Forty-four states had dynamic gaps that lasted at least 21 months with forty-one states below their potential output levels at the end of 2013.

On a regional level, an unusual pattern emerged. The Plains Region had a relatively homogeneous experience. Static losses in the Plains Region ranged from 8% in Iowa to 0% in North and South Dakota. Using the static gap, six of the eight regions had one state that had at least twice the losses of the other states in the region. This suggests that there is no strong pattern to the regional impact of the recession, rather the costs were borne across the nation.

The regional distribution of dynamic losses is more uniform since so many of the states were still below potential output. The ratio of the largest loss to the second largest ranges from 1.07 for the Great Lakes to 4.05 for the Southwest, much narrower than for the static losses.

Two sets of regressions were estimated, one for each of the different gap definitions. Independent variables measured educational levels within each state, the percentage employment in two sectors (construction and government, treated separately), the state foreclosure rate, and regional dummy variables. Overall, the regression models are able to explain 82 percent of the variation in each states static gap and 79 percent of the variation in each state's dynamic gap. As expected, the foreclosure rate in each state

played a significant negative role in each state's gap performance. No industry sectors tested significant, while the educational variables were important in explaining the static gap but not the dynamic gap. Overall, the regional fixed effects variables provide limited understanding, with only the Plains region testing significant and mitigating both the static and dynamic gaps in states within that region.

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## Appendix A: State gap measures.

| | | Static Losses | | | | | Dynamic Losses | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| State | BEA Region | Total Loss ($M) | Percent Loss | Start | End | Duration (quarters) | Total Loss ($M) | Percent Loss | Start | End | Duration (quarters) |
| Alabama | 5 | ($13,383) | -7.59% | 2008 III | 2011 III | 13 | ($93,763) | -53.19% | 2008 I | 2013 IV | 24 |
| Alaska | 8 | ($524) | -1.14% | 2008 I | 2008 II | 2 | ($725) | -1.58% | 2008 I | 2008 III | 3 |
| Arizona | 6 | ($109,572) | -40.21% | 2008 I | not yet | 24 | ($401,119) | -147.18% | 2008 I | 2013 IV | 24 |
| Arkansas | 5 | ($15,267) | -13.52% | 2008 I | 2011 III | 15 | ($79,042) | -69.99% | 2008 I | 2013 IV | 24 |
| California | 8 | ($333,174) | -16.47% | 2008 I | 2012 III | 19 | ($1,909,311) | -94.39% | 2008 I | 2013 IV | 24 |
| Colorado | 7 | ($15,299) | -5.98% | 2008 I | 2011 II | 14 | ($162,204) | -63.42% | 2008 I | 2013 IV | 24 |
| Connecticut | 1 | ($89,444) | -36.06% | 2008 I | not yet | 24 | ($229,969) | -92.72% | 2008 I | 2013 IV | 24 |
| Delaware | 2 | ($2,097) | -3.75% | 2008 I | 2009 I | 5 | ($25,410) | -45.40% | 2008 I | 2013 IV | 24 |
| Florida | 5 | ($408,372) | -50.80% | 2008 I | not yet | 24 | ($1,031,107) | -128.27% | 2008 I | 2013 IV | 24 |
| Georgia | 5 | ($79,135) | -18.55% | 2008 I | 2013 III | 23 | ($346,557) | -81.25% | 2008 I | 2013 IV | 24 |
| Hawaii | 8 | ($4,723) | -6.97% | 2008 III | 2011 III | 13 | ($29,835) | -44.05% | 2008 I | 2013 IV | 24 |
| Idaho | 7 | ($13,022) | -22.68% | 2008 III | 2013 II | 20 | ($66,604) | -115.99% | 2008 I | 2013 IV | 24 |
| Illinois | 3 | ($108,418) | -16.11% | 2008 I | 2013 III | 23 | ($362,247) | -53.82% | 2008 I | 2013 IV | 24 |
| Indiana | 3 | ($42,185) | -14.71% | 2008 I | 2011 IV | 16 | ($165,165) | -57.60% | 2008 I | 2013 IV | 24 |
| Iowa | 4 | ($11,451) | -8.06% | 2008 II | 2011 II | 13 | ($74,069) | -52.14% | 2008 I | 2013 IV | 24 |
| Kansas | 4 | ($6,349) | -5.08% | 2008 IV | 2010 II | 7 | ($42,156) | -33.71% | 2008 III | 2013 IV | 22 |
| Kentucky | 5 | ($10,534) | -6.43% | 2008 III | 2010 I | 7 | ($41,671) | -25.42% | 2008 I | 2013 IV | 22 |
| Louisiana | 5 | ($480) | -0.24% | 2008 I | 2008 I | 1 | ($635) | -0.31% | 2008 I | 2008 I | 1 |
| Maine | 1 | ($5,070) | -9.82% | 2008 III | Not yet | 22 | ($26,704) | -51.70% | 2008 I | 2013 IV | 24 |
| Maryland | 2 | ($2,742) | -0.90% | 2008 IV | 2009 III | 4 | ($146,249) | -47.87% | 2008 I | 2013 IV | 24 |
| Massachusetts | 1 | ($20,644) | -5.20% | 2008 III | 2010 II | 8 | ($193,503) | -48.79% | 2008 I | 2013 IV | 24 |
| Michigan | 3 | ($125,310) | -30.32% | 2008 I | not yet | 24 | ($171,859) | -41.58% | 2008 I | 2013 IV | 24 |
| Minnesota | 4 | ($14,237) | -5.28% | 2008 IV | 2010 III | 8 | ($123,893) | -45.95% | 2008 III | 2013 IV | 23 |
| Mississippi | 5 | ($12,965) | -13.47% | 2008 III | 2013 II | 20 | ($45,960) | -47.76% | 2008 I | 2013 IV | 24 |
| Missouri | 4 | ($3,649) | -1.43% | 2008 III | 2011 III | 13 | ($70,679) | -27.79% | 2008 I | 2013 IV | 24 |

## State gap measures (continued).

| | | Static Losses | | | | | Dynamic Losses | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| State | BEA Region | Total Loss ($M) | Percent Loss | Start | End | Duration (quarters) | Total Loss ($M) | Percent Loss | Start | End | Duration (quarters) |
| Montana | 7 | ($2,741) | -7.37% | 2008 I | 2010 IV | 12 | ($20,667) | -55.59% | 2008 I | 2013 IV | 24 |
| Nebraska | 4 | ($801) | -0.93% | 2008 IV | 2009 II | 3 | ($10,326) | -11.97% | 2008 III | 2013 IV | 22 |
| Nevada | 8 | ($94,568) | -68.11% | 2008 I | not yet | 24 | ($236,374) | -170.23% | 2008 I | 2013 IV | 24 |
| N. Hampshire | 1 | ($3,119) | -5.01% | 2008 I | 2011 III | 15 | ($34,706) | -55.75% | 2008 I | 2013 IV | 24 |
| New Jersey | 2 | ($91,801) | -17.84% | 2008 II | not yet | 23 | ($303,770) | -59.05% | 2008 II | 2013 IV | 23 |
| New Mexico | 6 | ($635) | -0.78% | 2009 II | 2010 III | 6 | ($29,510) | -36.32% | 2008 I | 2013 IV | 24 |
| New York | 2 | ($15,156) | -1.33% | 2008 II | 2009 I | 4 | ($331,461) | -29.02% | 2008 II | 2013 IV | 23 |
| North Carolina | 5 | ($15,081) | -3.60% | 2008 III | 2011 I | 11 | ($248,795) | -59.34% | 2008 I | 2013 IV | 24 |
| North Dakota | 4 | $0 | | | | 0 | $0 | | | | 0 |
| Ohio | 3 | ($66,105) | -13.02% | 2008 III | 2011 III | 13 | ($175,018) | -34.47% | 2008 I | 2013 IV | 24 |
| Oklahoma | 6 | ($1,007) | -0.68% | 2009 II | 2010 I | 4 | ($49,158) | -33.38% | 2009 I | 2013 IV | 20 |
| Oregon | 8 | ($27) | -0.01% | 2009 II | 2009 II | 1 | ($61,867) | -34.66% | 2008 I | 2013 IV | 24 |
| Pennsylvania | 2 | ($25,452) | -4.33% | 2008 III | 2010 II | 8 | ($223,936) | -38.13% | 2008 I | 2013 IV | 24 |
| Rhode Island | 1 | ($1,117) | -2.31% | 2008 II | 2009 IV | 7 | ($20,469) | -42.41% | 2008 I | 2013 IV | 24 |
| South Carolina | 5 | ($23,049) | -13.56% | 2008 I | 2011 III | 15 | ($97,486) | -57.36% | 2008 I | 2013 IV | 24 |
| South Dakota | 4 | $0 | 0.00% | 0 | 0 | 0 | ($9,841) | -27.91% | 2008 IV | 2013 IV | 21 |
| Tennessee | 5 | ($27,493) | -10.55% | 2008 I | 2011 III | 15 | ($129,155) | -49.58% | 2008 I | 2013 IV | 24 |
| Texas | 6 | ($14,795) | -1.26% | 2008 I | 2009 IV | 8 | ($396,349) | -33.65% | 2008 I | 2013 IV | 24 |
| Utah | 7 | ($11,431) | -9.56% | 2008 I | 2011 II | 14 | ($107,341) | -89.80% | 2008 I | 2013 IV | 24 |
| Vermont | 1 | ($737) | -2.85% | 2008 IV | 2010 I | 6 | ($9,361) | -36.21% | 2008 II | 2013 IV | 23 |
| Virginia | 5 | ($3,441) | -0.84% | 2008 IV | 2009 III | 4 | ($215,831) | -52.96% | 2008 I | 2013 IV | 24 |
| Washington | 8 | ($38,505) | -10.53% | 2008 I | 2011 III | 15 | ($233,693) | -63.94% | 2008 I | 2013 IV | 24 |
| West Virginia | 5 | $0 | 0.00% | 0 | 0 | 0 | ($757) | -1.22% | 2009 II | 2010 I | 4 |
| Wisconsin | 3 | ($16,863) | -6.59% | 2008 II | 2010 III | 10 | ($113,409) | -44.34% | 2008 I | 2013 IV | 24 |
| Wyoming | 7 | ($13) | -0.04% | 2009 IV | 2009 IV | 1 | ($21,380) | -59.81% | 2009 II | 2013 IV | 19 |